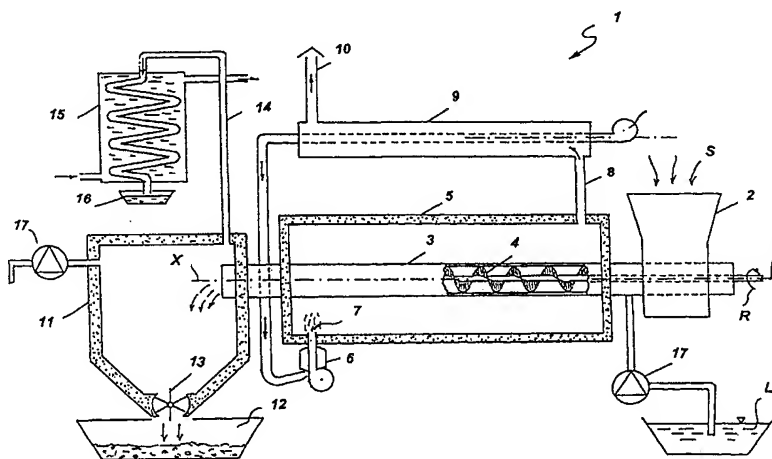




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(54) Title: APPARATUS AND PROCESS FOR THERMAL TREATMENT OF WASTE



## (57) Abstract

Apparatus for thermal treatment of solid or liquid waste, by processing the waste material by way of dry distillation and drying, which includes an inlet funnel (2) for introducing the waste material (S, L) to be treated, a heating oven (5), a burner (6) connected to the heating oven (5), containing a cylindrical air-tight drying chamber (3), provided with apparatus for avoiding contact with atmospheric air, where the waste material is heated, a screw conveyor (4) for continuous conveyance of the waste through the drying chamber (3), an outlet zone for extracting the thermally treated waste material, separated in fluid and solid components, vessels (16, 12) for collection of the fluid and solid components, a thermally insulated air-tight evaporation chamber (11), connected downstream of the drying chamber for receiving the heated waste material and for separating by evaporation solid and fluid components of the waste, and provided with outlet passages (14, 13) for extracting vapours and solid components and a condenser (15) placed downstream of the evaporation chamber to condense the vapours to their liquid state. A method of thermal treatment of the waste is also disclosed.

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## APPARATUS AND PROCESS FOR THERMAL TREATMENT OF WASTE

### Technical Field

5 The present invention relates to an apparatus for thermal treatment of wastes, especially of liquids or solid wastes or sludges containing organic materials, and to a process for carrying out the treatment. They are employed, for example, in the tanning industry or in domestic waste purifying plants.

10

### Background Art

Apparatuses of the above-cited type are generally constituted by a heating chamber where the waste is continuously fed by means of a transportation  
15 system and heated by direct contact with flames or with heated gases. These gases have the function of transmitting the necessary heat to the process and to extract the vapours produced during the drying process.

Such vapours can originate from water or from any other liquid which should  
20 be separated from the solid part of the waste, like solvents, for instance.

In these plants the quantity of vapour extracted by the warm air passing through the drying chamber, generally of cylindrical shape, depends on the wet bulb temperature of the system which can be found from the Mollier  
25 diagram of wet air. This temperature is dependent on many factors like the initial humidity of the process air, before being submitted to heating, the value of the heating temperature, and the introduction of unwanted air, which can make the temperature fluctuate. The air wet bulb temperature corresponds also to the temperature reached by the waste material under  
30 treatment. All these mentioned elements are not easily controlled in the

existing drying plants because of the lack of control on the air mass introduced in the system by induced draughts.

Some plants operate by heating up the waste material in direct contact with the heating flames.

In this type of process one important factor for reaching high plant efficiency is to reach a high drying temperature because it favours evaporation of water and reduces internal physical or chemical bounds of the waste material itself.

10

Moreover if the process temperature remains low, the drying speed of the system will also be low and a higher quantity of air will be needed for vapour extraction.

From the European patent EP-A-401460 there is known an apparatus for thermal treatment of waste which reduces the volume of the waste through distillation and contact with gases and cleans the burnt gases before releasing them in the atmosphere. A drawback of such known apparatus is its complexity and operating costs.

20

### **Disclosure of the Invention**

One general aim of the present invention is to obviate the above described drawbacks by providing an apparatus for thermal treatment of waste, in particular of solid or liquid waste, containing organic material, able to treat muds, sludges, pulps and similar matter, containing suspensions of pigments, clays or minerals, originating for example from filters or settling systems, as well as dry powders like clays, pigments, precipitates, cements, crystals, sands, minerals or synthetic rubber, by drying or distillation in a atmosphere of vapours.

30

A further aim of the present invention is to provide an apparatus working in a continuous process, at the boiling temperature of the liquids contained in the waste material.

5

A particular aim of the present invention is to provide an apparatus which allows recovery of heat and has a high efficiency.

Another aim is to provide an apparatus which eliminates atmospheric  
10 pollution by means of vapours recovery.

It is still another aim to conceive a method of thermal treatment of waste in an apparatus as above indicated, which works as a continuous process, has high overall efficiency and is cost effective.

15

In accordance with one preferred aspect of the invention, there is provided an apparatus which comprises an inlet zone for introducing the waste material to be treated, a heating oven, heating means connected to said heating oven, a drying chamber, where waste material is heated, located inside said heating  
20 oven, transportation means for continuous conveyance of the waste through said drying chamber, an outlet zone for extracting the thermally treated waste material, separated in fluid and solid components, means for respective collection of said solid and fluid components, wherein said drying chamber is air-tight and is provided with means avoiding contact with atmospheric air,  
25 said apparatus being further provided with a thermally insulated air-tight evaporation chamber, connected downstream of said drying chamber for receiving the heated waste material and for separating solid and fluid components, and said evaporation chamber having outlet passages for extracting respectively said fluid and solid components, said fluid components  
30 being in vapour state.

Due to this, the thermal treatment of waste is made without contact either with the combustion gases or with unwanted atmospheric air, thus increasing efficiency and reducing pollution.

- 5 Advantageously, the apparatus comprises condenser means downstream of the evaporation chamber to condense said fluid components to their liquid state.

According to another aspect of the invention, there is provided a method of  
10 thermal treatment of waste in a treatment apparatus, in particular solid waste, containing organic matter, which method contains the following steps:

- inserting the waste material in an inlet portion of the apparatus,
- conveying the waste material with appropriate speed through a drying chamber of the apparatus, which is air-tight and with no contact with the  
15 atmospheric air, where the waste material is heated to a predetermined temperature to reach an appropriate humidity degree,
- discharging the waste material in a thermally insulated zone of the apparatus, where an appropriate pressure is maintained and where solid components are separated from fluid components by evaporation.

20

#### **Brief Description of Drawings**

Further characteristics and advantages of the invention will become more apparent in light of the following detailed description of some preferred but  
25 not exclusive embodiments of an apparatus for thermal treatment of waste, in particular solid or liquid waste, containing organic material, and of a method for carrying out a process for thermal treatment of waste, in particular solid or liquid waste, containing organic material, in accordance with the invention, by means of the cited apparatus illustrated with the help of the attached  
30 drawing sheet in which:

Fig. 1 illustrates a schematic view of the apparatus according to one preferred aspect of the invention;

5 **Detailed Description of the Invention**

With reference to the cited figure 1 there is illustrated an apparatus for thermal treatment of waste, identified globally with the reference numeral 1.

10 The apparatus has an inlet funnel 2 where the waste material S, solid, liquid or sludge, to be treated is fed continuously and passes subsequently through a drying cylindrical elongated chamber 3, made of stainless steel or equivalent metal, where continuous conveyance is guaranteed by a screw conveyor 4, or similar, which rotates around its axis X in direction R. An  
15 electrical engine, not shown in the figure drives the screw conveyor 4 with variable rotation speed so as to define a period of retention of the waste material in the drying chamber 3 of appropriate length depending on the composition of the material to be treated.

20 The screw conveyor performs additionally a cleaning function of the internal surface of the walls of the drying chamber to avoid that the waste adheres to it during heating, with consequent reduction of efficiency of the whole process.

25 The drying chamber 3 is contained, for most of its length, in a heating oven 5, thermally insulated, where combustible is burnt or combustion gases, produced by a separate burner 6, are introduced through one or more inlets  
7.

30 An outlet duct 8, collects the combusted fumes from the oven 5 and directs

them to an heat exchanger 9 for residual heat recovery. This heat is then used for warming up the air to be used in the combustion in the oven 5. Finally the combusted gases are released in the atmosphere through the outlet 10.

5

The drying chamber 3 is, in accordance with the invention, air-tight and no contact is allowed to the waste material either with the atmospheric air after it has entered the chamber 3 or with combustion gases in the heating oven 5.

- 10 At the inlet side of the apparatus 1, in funnel 2 air-tightness is advantageously achieved by means of the waste material itself which acts as a plug and prevents air from entering into the drying chamber 3.

15 An air-tight evaporation chamber 11, connected downstream of the drying chamber receives the waste material after the heating stage, where the waste material, at high temperature, separates its vapour component from its solid one.

20 The solid component falls into the collecting vessel 12, after passing through the vacuum rotary valve 13, which ensures that the pressure in the evaporation chamber 11 remains, during operation, at a level different from the atmospheric one. In its upper portion the evaporation chamber has an outlet passage 14 for extracting vapours and leading them through a condenser 15 into a collecting vessel 16 after their condensation to the liquid state.

25

This evaporation chamber 11 is appropriately insulated thermally to avoid having a lower temperature on the walls with consequent condensation of vapours and acid production. This could corrode the structure of the chamber 30 11 itself.



The evaporation chamber 11 is also provided with a pump 17 for producing an appropriate vacuum degree, usually some millimetres of water, or an appropriate overpressure. Different pressures from the atmospheric one are necessary whenever the fluids contained in the waste have different boiling  
5 temperatures than that of water.

The condenser 15 has also a heat recovery function for improving energy efficiency of the whole apparatus and the warm fluid extracted from it can be used for other industrial or domestic purposes.

10

Advantageously the apparatus is also provided with a pump 17 for feeding the waste material L whenever it is made only of liquids, or has a mainly liquid state, which can be activated on its own or in combination with the screw conveyor 4 during operation of the apparatus.

15

The apparatus operates in the following steps which also implement the steps of the process for thermal treatment according to the invention.

The waste material is inserted in the inlet funnel 2 and is continuously fed by  
20 the screw conveyor 4 into the cylindrical drying chamber 3.

In the portion of the chamber 3 surrounded by the oven 5 the waste material is heated up to the boiling temperature of the fluids it contains by combustion gases inlet through nozzles 7. As the combustion gases do not contact  
25 directly the waste material they do not mix to the vapours generated from the waste itself and can be released into the atmosphere without the need to be cleaned from polluting substances.

In this manner a further disadvantage of existing apparatuses, i. e. the fact  
30 that the mixture of vapours and combustion gases substantially reduces the

acid dew point of the combustion products is avoided, thus preventing corrosion problems in the apparatus.

After the heating phase in the drying chamber 3, till the boiling temperature of the waste fluids and the appropriate degree of humidity is reached, the mixture of vapour and solid waste material enters in the evaporation chamber 11. Here the vapours separate from the solid component. The vapours are extracted through the duct 14 and pass through the condenser 15 where they condense and are collected as liquids in the vessel 16. They can be appropriately disposed of without danger of pollution.

The solid components, completely free of vapours and liquids, fall by gravity to the bottom of the evaporation chamber 11 and are collected in the vessel 12.

Tests made on the apparatus above described have given the following results. In the thermal treatment of tanning sludges, residual from process water cleaning, in a steady state, the following values were obtained:

- Inlet: 100 kg wet mud;
- Outlet: 48 kg dry mud with 2, 208 kg trivalent Chrome, equal to 4.6% and less than 0.2 mg/kg hexavalent Chrome, defined as absent;
- 52 kg condensate, rich in fat, bad-smelling proteic substances sent to the cleaning plant;
- Energy consumption: 30000 Kcal.

From what has been described heretofore it is apparent that the apparatus according to the invention offers all the expected advantages of high efficiency and low energy consumption.

Although the invention has been described with reference to particular

means, material, and embodiments, it is to be understood that the invention is not limited to the particulars disclosed and extends to all equivalents within the scope of the claims.

- 5 The instant application is based upon Italian patent application VI98A000163, filed on 7 September 1998, the disclosure of which is hereby expressly incorporated by reference thereto, and the priority of which is hereby claimed.

## CLAIMS

1. Apparatus for thermal treatment of waste, in particular solid or liquid waste, by processing the waste material by way of distillation and drying,  
5 comprising:

an inlet zone (2) for introducing the waste material (S, L) to be treated;  
a heating oven (5);

heating means (6) connected to said heating oven (5);

a drying chamber (3), where waste material is heated, located inside  
10 said heating oven (5);

transportation means (4) for continuous conveyance of the waste  
through said drying chamber (3);

an outlet zone for extracting the thermally treated waste material,  
separated in fluid and solid components;

15 means (16, 12) for respective collection of said fluid and solid  
components;

wherein said drying chamber (3) is air-tight and is provided with means  
for avoiding contact with atmospheric air, said apparatus being further  
provided with a thermally insulated air-tight evaporation chamber (11),  
20 connected downstream of said drying chamber (3) for receiving the heated  
waste material and for separating solid and fluid components, said  
evaporation chamber (11) having outlet passages (14, 13) for extracting  
respectively said fluid and solid components, said fluid components being in  
vapour state.

25

2. Apparatus according to claim 1, characterised in that condenser means  
(15) are provided downstream of said evaporation chamber to condense said  
fluid components to their liquid state.

30 3. Apparatus according to claim 2, characterised in that heat recovery means

are associated with said condenser means (15).

4. Apparatus according to claim 1, characterised in that said outlet passage  
5 (13) of said evaporation chamber (11) for extracting solid components is provided with a vacuum valve for air tight separation from the collection means (12).

5. Apparatus according to claim 1, characterised in that said transportation  
10 means located in the drying chamber comprise a screw conveyor (4).

6. Apparatus according to claim 5, characterised in that said screw conveyor (4) is provided with drive means apt to vary its rotation speed.

15 7. Apparatus according to claim 1, characterised in that pump means (17) are connected to said evaporation chamber (11) for producing inside the latter a pressure different from the atmospheric pressure.

8. Apparatus according to claim 1, characterised in that there is provided  
20 heat recovery means (9) of exhaust combustion gases of the heating oven (5).

9. A method of thermal treatment of waste in a treatment apparatus, in particular solid (S) or liquid (L) waste, which method contains the following  
25 steps:

- inserting the waste material in an inlet portion (2) of the apparatus,
- conveying the waste material with appropriate speed through a drying chamber (3) of the apparatus, which is air-tight and with no contact with the atmospheric air, where the waste material is heated to a predetermined  
30 temperature,

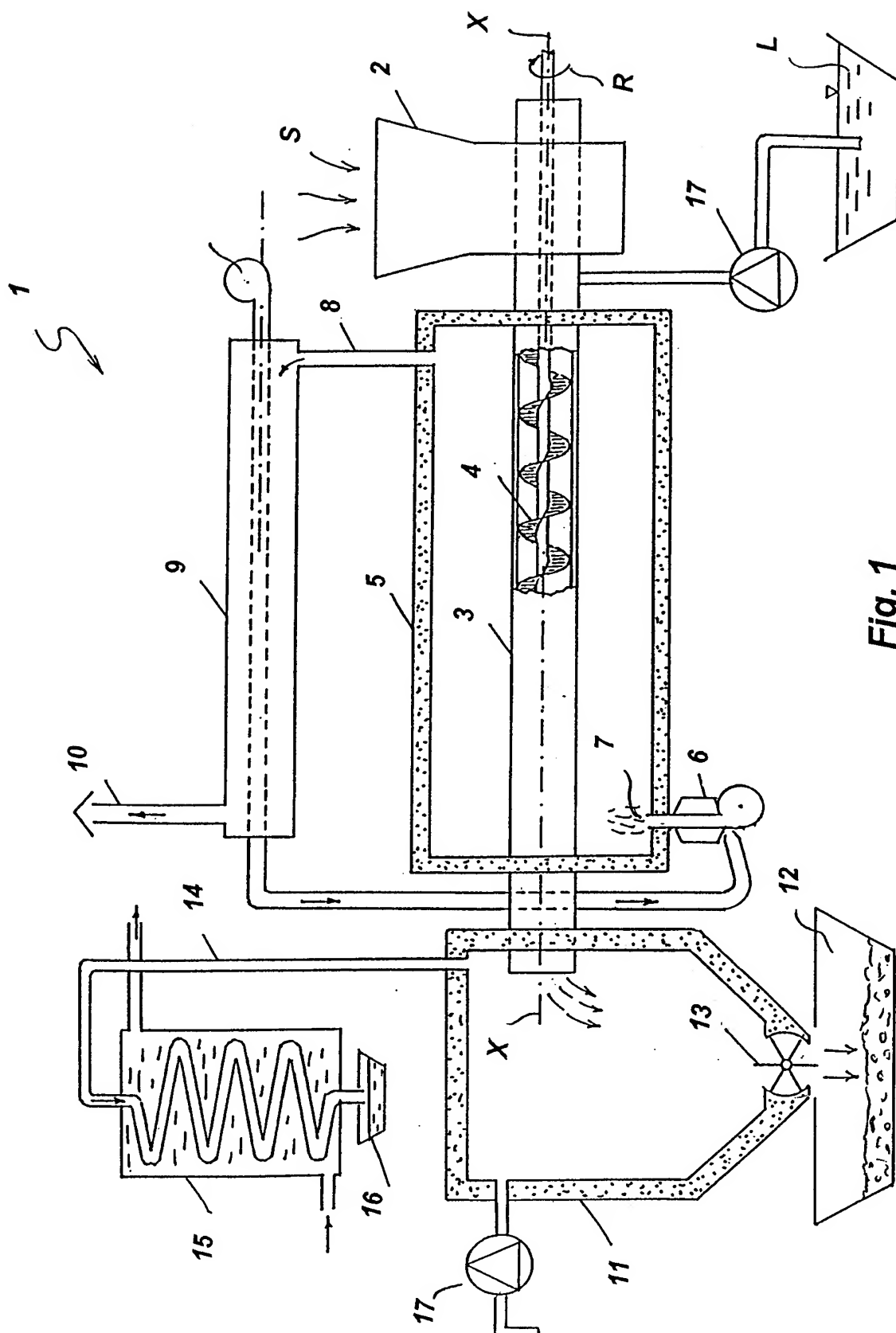
- discharging the waste material in a thermally insulated zone (11) of the apparatus, where an appropriate pressure is maintained and where solid components are separated from fluid components by evaporation.

5 10. A method according to claim 9 characterised in that said predetermined temperature is the boiling temperature of the liquid component of the waste material.

11. A method according to claim 10 characterised in that the evaporated fluid  
10 components are subjected to condensation and heat recovery.

12. A method according to claim 10 characterised in that there is further provided heat recovery from exhaust combustion gases of the heating oven (5).

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## INTERNATIONAL SEARCH REPORT

International Application No

PCT/IB 99/01513

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC 7 B09B3/00 C02F11/12

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B09B C02F F26B B09C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 524 463 A (LINDE) 27 January 1993 (1993-01-27) column 6, line 42 -column 7, line 47	1,2, 8-10,12
Y	figure 1	3-7,11
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Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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